Chapter 3
Risk

Chapter Contents

This chapter addresses the exposures and associated risks that may result from using the substitute blanket washes. Section 3.1 contains information on environmental releases. Potential releases to air, and land and water are discussed for each blanket wash. Section 3.2 examines potential occupational exposures. The dermal and inhalation exposures that can occur as a result of working with a blanket wash are presented. Section 3.3 addresses exposures for the general population (i.e., people not working in the print shop), and includes information on human exposures to blanket wash chemicals released to both air and surface water. In all three sections, the methodologies and models used for estimating releases and exposures are described along with the associated assumptions and uncertainties. Section 3.4 moves from exposures to the risks and concerns associated with such exposures. Descriptions of how risk characterizations are made and the types of risks examined (such as carcinogenic, chronic and developmental), are followed by discussions of the risks assigned to the environmental, occupational and general population exposures discussed earlier in the chapter. In Section 3.5, methods of reducing worker risk are discussed. Topics such as employee training, proper handling of chemicals, and use of personal safety equipment and equipment safeguards are reviewed.

3.1 ENVIRONMENTAL RELEASE ESTIMATES

Estimated environmental releases associated with lithography blanket wash chemicals and the methodology, assumptions and uncertainties associated with the release calculations are discussed below. Releases to air result from volatilization of volatile blanket wash constituents during fluid (blanket wash) transfers and from waste rags used to wipe blanket wash liquid off of the blankets. Releases to water result primarily from the laundering of dirty reusable rags. Releases to land result from the disposal of non-reusable rags.

Methodology - Environmental Releases

The material balance approach was used to calculate releases from lithography blanket washes. Figure 3-1 decribes the overall material balance:

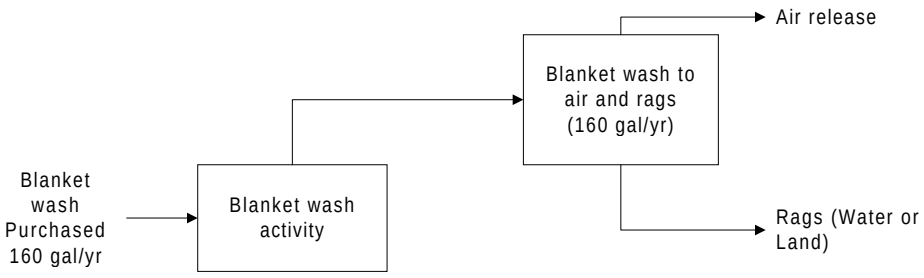

Figure 3-1. Material Balance

General facility assumptions were developed specifically for the scenarios of this assessment. These assumptions were developed by EPA in conjunction with Gary Jones of the Graphic Arts Technical Foundation (GATF) and were released for review during the ECB/GATF Environmental Affairs Conference held in Oakbrook, Illinois in March 1994. Those assumptions were as follows:

Assumption	Value
Number of presses per facility	1-19"x 26"
Number of units per press	4
Number of times each blanket is washed per day	10 (40 total for the press)[1]
Number of hours per operating day	8
Number of operating days per year	250
Average amount of wash used per blanket	2 oz.
Area of 1 blanket	3.4 ft^2
Amount of blanket wash used per year	160 gallons

[1] Industry commentators noted during a later review of draft results that washing the blanket 10 times per day may be high for this type of facility. If this assumption is high, using 10 blanket washes per day may overestimate exposures.

An average of 160 gallons of blanket wash is assumed to be used per year per facility (rounded to two significant figures). The 160 gallons is either released to air or is left on the rag for disposal or laundering.

A typical shop may either use reusable rags, which are laundered, or dispose of rags as municipal solid waste. Volatile chemicals (>10^{-3} mm Hg vapor pressure) were assumed to be released to air whether reusable or disposable rags are used. Non-volatile chemicals ($\leq 10^{-3}$ mm

Hg vapor pressure[a]) were assumed to remain on the rags. Chemicals remaining on reusable rags were released to water and chemicals remaining on disposal rags were released to land. **The model does not take into account the releases of ink constituents that are being removed in the blanket wash.**

The material balance calculations are conducted as follows for each formulation:

- Calculate the average density of the formulation using the normalized weight percent; (see sample calculation)
- Multiply the average density by the volume released (160 gallons) to get the total mass of blanket wash released;
- Multiply the total mass by the weight percentage of each chemical in the formulation to determine individual chemical masses;
- If the vapor pressure of a chemical constituent is > 10^{-3} mm Hg, then the chemical is assumed to be released to air; and
- If the vapor pressure is ≤ 10^{-3} mm Hg, then the chemical will not volatilize and is assumed to be released to water or land. Releases to water occur when the rags are laundered, and to land when they are disposed of.

Sample Calculation

Example Formulation	Density (g/cm^3)	Weight Percent	Vapor Pressure (mmHg)
Ethoxylated nonylphenol	0.8	42.9%	$<10^{-6}$
Solvent naphtha, heavy	0.87	33.3%	0.5
Propylene glycol monobutyl ether	0.89	19.0%	<0.98
Tetrapotassium pyrophosphate	2.33	4.8%	$<10^{-6}$

[a] *An industry reviewer commented that the 10^{-3} mm Hg cutoff may be low. This figure was developed by EPA's Health and Environmental Effects Division for the New Chemicals Review Program to be protective of human health. Below 10^{-3} mm Hg no further concern for inhalation risks is warranted. Above 10^{-3} mm Hg there may or may not be concerns.*

In this example:

- The average density of the blanket wash is 0.867 g/cm

$$\sum_{I=1}^{n} \frac{\text{weight fraction}_i}{\text{density}_i} = \sum_{i=1}^{n} \frac{\frac{g_i}{g_{formulation}}}{\frac{g_i}{cm^3_i}} = \sum_{i=1}^{n} \frac{cm^3_i}{g_{formulation}}$$

$$= \frac{cm^3_{formulation}}{g_{formulation}}$$

The reciprocal of this value is the average density of the blanket wash in g/cm^3.

In this example, we have

$$\frac{1}{\left[\frac{0.429}{0.8} + \frac{0.333}{0.87} + \frac{0.19}{0.89} + \frac{0.48}{2.33}\right]} = 0.867 \text{ g/cm}^3$$

- Using the average density, the total mass of blanket wash per year is calculated to be 525,196 g/yr.
- The mass of each chemical component is calculated, the vapor pressure is evaluated to determine the release route and the following release rates are calculated:

Example Formulation	Release to Air* (g/site/sec)	Release to Water or Land (kg/site/yr)
Ethoxylated nonylphenol	0	225.3
Solvent Naphtha, heavy	0.024	0
Propylene glycol monobutyl ether	0.014	0
Tetrapotassium pyrophosphate	0	25.2
Total:	0.038	251

* The time units for releases to air are calculated using 250 days per year and 8 hours per day. The environmental releases for each blanket wash formulation are provided in Table 3-1.

Assumptions - Environmental Releases

The material balance used in this report assumes that releases to air equal the total air release of chemicals from the following:

- Volatilization of blanket wash formulation constituents from blankets during cleaning;

- Emissions from transfer operations; and
- Volatilization of blanket wash constituents from dirty rags.

As described on page 3-2, the following assumptions and sources of information were used in the material balance model:

- Chemicals with a vapor pressure $\leq 10^{-3}$ mm Hg will not volatilize;
- Chemicals that do not volatilize will remain on the cleaning rags.
- The general facility assumptions listed above.

Uncertainties - Environmental Releases

Determining environmental releases associated with lithography blanket washes requires making assumptions about the cleaning process, the workplace environment and waste management practices. Uncertainties about the amounts of releases to the environment stem from the estimated total released per year (160 gallons). This total will vary in actual printing facilities based on:

- type of blanket wash used;
- amount of blanket wash applied;
- amount of unused blanket wash disposed;
- compliance with waste management procedures;
- equipment operating time;
- temperature conditions (ambient and solvent);
- chemical properties.

Table 3-1. Environmental Releases: Lithographic Blanket Washes

Form. Number	Formulation**	Environmental Releases	
		Air (g/sec)	Water or Land (kg/yr)
1	Fatty acid derivatives	0.062	0
	Alkoxylated alcohols	0.014	0
3	Hydrocarbons, petroleum distillates	0.021	0
	Fatty acid derivatives	0	152
	Hydrocarbons, aromatic	0.025	0
	Alkyl benzene sulfonates	0	38
4	Terpenes	0.059	0
	Ethoxylated nonylphenol	0	77
5	Water	N/A	N/A
	Hydrocarbons, aromatic	0.021	0
	Ethylene glycol ethers	0.010	0
	Ethoxylated nonylphenol	0	50
	Alkyl benzene sulfonates	0	30
	Alkoxylated alcohols	0	15
	Alkali/salts	0	5
6	Fatty acid derivatives	0	329
	Hydrocarbons, petroleum distillates	0.018	0
	Hydrocarbons, aromatic	0.006	0
	Alkyl benzene sulfonates	0	25

Form. Number	Formulation**	Environmental Releases	
		Air (g/sec)	Water or Land (kg/yr)
7	Terpenes	0.071	0
	Ethoxylated nonylphenol	0	15
	Alkoxylated alcohols	0	15
8	Water	N/A	N/A
	Hydrocarbons, aromatic	0.018	0
	Propylene glycol ethers	0.012	0
	Alkyl benzene sulfonates	0	91
	Ethoxylated nonylphenol	0	43
	Alkoxylated alcohols	0	13
	Alkali/salts	0	4
9	Fatty acid derivatives	0	405
	Water	N/A	N/A
	Ethoxylated nonylphenol	0	15
10	Fatty acid derivatives	0	140
	Water	N/A	N/A
11	Fatty acid derivatives	0	249
	Hydrocarbons, petroleum distillates	0.028	0
	Hydrocarbons, aromatic	0.005	0
	Alkyl benzene sulfonates	0	23
12	Hydrocarbons, petroleum distillates	0.033	0
	Water	N/A	N/A
14	Fatty acid derivatives	0	54
	Propylene glycol ethers	0.008	0
	Water	N/A	N/A
16	Terpenes	0.075	0
17	Ethoxylated nonylphenol	0	11
	Glycols	0.002	0
	Fatty acid derivatives	0	5
	Alkali/salts	0	3
	Water	N/A	N/A
18	Fatty acid derivatives	0	225
	Hydrocarbons, petroleum distillates	0.022	0
	Hydrocarbons, aromatic	0.005	0
	Dibasic esters	0.009	0
	Esters/lactones	0.003	0
	Alkyl benzene sulfonates	0	23
19	Fatty acid derivatives	0	182
	Propylene glycol ethers	0.051	0
	Water	N/A	N/A
20	Water	N/A	N/A
	Hydrocarbons, petroleum distillates	0.010	0
	Hydrocarbons, aromatic	0.007	0
	Alkyl benzene sulfonates	0	25

Form. Number	Formulation**	Environmental Releases	
		Air (g/sec)	Water or Land (kg/yr)
21	Hydrocarbons, aromatic	0.014	0
	Hydrocarbons, petroleum distillates	0.021	0
	Fatty acid derivatives	0	257
22	Fatty acid derivatives	0	288
	Hydrocarbons, aromatic	0.017	0
	Water	N/A	N/A
23	Terpenes	0.034	0
	Nitrogen heterocyclics	0.021	0
	Alkoxylated alcohols	0.021	0
	Water	N/A	N/A
24	Terpenes	0.013	0
	Ethylene glycol ethers	0.003	0
	Ethoxylated nonylphenol	0	23
	Alkyl benzene sulfonates	0	35
	Alkali/salts	0	23
	Water	N/A	N/A
25	Terpenes	0.072	0
	Esters/lactones	0.003	0
26	Fatty acid derivatives	0	604
	Esters/lactones	0	256
27	Terpenes	0.12	0
28	Hydrocarbons, petroleum distillates	0.059	0
29	Fatty acid derivatives	0	533
30	Hydrocarbons, aromatic	0.049	0
	Propylene glycol ethers	0.008	0
	Water	N/A	N/A
31	Hydrocarbons, aromatic	0.010	0
	Hydrocarbons, petroleum distillates	0.058	0
32	Hydrocarbons, petroleum distillates	0.066	0
33	Hydrocarbons, petroleum distillates	0.018	0
	Hydrocarbons, aromatic	0.018	0
	Propylene glycol ethers	0.004	0
	Water	N/A	N/A
34	Water	N/A	N/A
	Terpenes	0.015	0
	Hydrocarbons, petroleum distillates	0.012	0
	Alkoxylated alcohols	0	42
	Fatty acid derivatives	0	42
35	Hydrocarbons, petroleum distillates	0.010	0
	Hydrocarbons, aromatic	0.058	0
36	Fatty acid derivatives	0	376
	Hydrocarbons, petroleum distillates	0.013	0
	Hydrocarbons, aromatic	0.007	0
	Propylene glycol ethers	0.003	0

Form. Number	Formulation**	Environmental Releases	
		Air (g/sec)	Water or Land (kg/yr)
37	Water	N/A	N/A
	Hydrocarbons, petroleum distillates	0.034	0
	Hydrocarbons, aromatic	0.003	0
38	Hydrocarbons, petroleum distillates	0.048	0
	Alkoxylated alcohols	0.012	0
	Fatty acid derivatives	0	0
39	Water	N/A	N/A
	Hydrocarbons, petroleum distillates	0.015	0
	Propylene glycol ethers	0.008	0
	Alkanolamine	0	17
	Ethylene glycol ethers	0.004	0
40	Hydrocarbons, aromatic	0.009	0
	Hydrocarbons, petroleum distillates	0.012	0
	Fatty acid derivatives	0	346
	Ethoxylated nonylphenol	0	22

**Formulation compositions were adjusted to equal 100 percent.
N/A - Not applicable

3.2 OCCUPATIONAL EXPOSURE ESTIMATES

Inhalation and dermal exposure associated with lithography blanket wash chemicals and the methodology, assumptions and uncertainties associated with the estimates are discussed below. The scenario described below was modelled to assess inhalation and dermal exposures for workers at these shops. Table 3-2 presents the inhalation and dermal exposures for lithographic blanket washes.

Table 3-2. Inhalation and Dermal Exposures: Lithographic Blanket Washes

Form. Number	Formulation[1]	Inhalation Exposure[2] (mg/day)	Dermal Exposure[3] (mg/day)
1	Fatty acid derivatives	0.23	1,100-3,300
	Alkoxylated alcohols	0.026	200-590
3	Hydrocarbons, petroleum distillates	7.2	730-2,200
	Fatty acid derivatives	negligible	390-1,200
	Hydrocarbons, aromatic	14.8	121-360
	Alkyl benzene sulfonates	negligible	61-180
4	Terpenes	74	1,100-3,400
	Ethoxylated nonylphenol	negligible	159-480